

Yawning need for rainwater harvesting

Water shortage – both portable and irrigation – in Pakistan is getting critical with every passing day mainly due to the negative impacts of climate change and subsequent rise in whether temperature. Water flows in rivers are constantly on the decline while storage capacity of water reservoirs is shrinking leaving less water availability for irrigation human usage. If this situation persists in the country, which heavily depends on agriculture sector for survival, would face food security issue in near future. Since most regions across the globe suffer water shortage, various rain water conservation methods like groundwater exploration, aquifer recharge technique, water conservation and rainwater harvesting have been developed. Rainwater harvesting has emerged the only method to control flooding and conserve water for multiple purposes. India has made it mandatory for all new structures in big cities to have provision for rain water harvesting. Estimates suggest that 60 per cent of the world population would be urbanized by 2025. Reduced water supplies subsequently would place additional stress on people, agriculture and environment and could spark conflicts. Improved water resource management, however, can help reduce vulnerabilities. Rainwater harvesting is a technology used to collect, convey and store rain from relatively clean surfaces such as a roof, land surface or rock catchments for later use. This technique can provide water for human consumption, reduce water bills and lessen the needs to build reservoirs, which may require the use of valuable land. Pakistan's Potohar Plateau including Chakwal, Jhelum, Attock and Rawalpindi districts of Punjab province, covers an area of 2.2 million hectares and receives as much as 70 per cent of its precipitation in just the monsoon season. The rainwater harvesting can be a cheap, safe and sustained way of water supply throughout the year. It has been observed that farmers hardly adopt news agriculture techniques and remain stuck to the conventional methods, which are not workable in the modern day needs. The adverse impacts of climate change could exacerbate the crisis in the country on the verge of being classified as 'water scarce' with per capita water availability falling to 1,000 cubic metres. This method also helps raise the groundwater table from 450 feet to 200 feet in rural areas. Rainwater harvesting is a relatively new and innovative concept for many farmers in the country, however, the farmers community could be sensitized about the benefits of this technique. The government needs to come up with feasible rainwater harvesting programmes for arid areas of the country, otherwise, growing water stress has the potential to turn the situation into a catastrophe.

REPORT

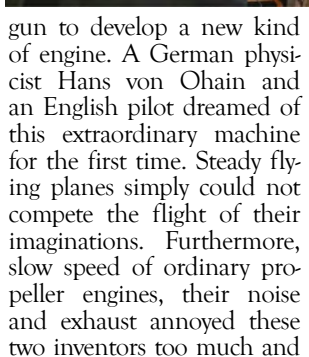
Small scale gas turbine jet engine developed indigenously

MOST OF us would have surely seen supersonic jets cruising in the high skies with speeds greater than the speed of sound. Their terrifying sound and excellent maneuverability have always fascinated us but the question which provoked my curiosity since childhood was that what those covert forces are which enable this magnificent flight. Flying like birds have been a very old dream of mankind which became a reality when we understood the basic forces of nature like lift, drag and pressure. However, man didn't only rely on the invention of airplane but now he wanted to fly faster and faster in the skies. Propeller engines were not powerful enough to make this ambitious dream come true hence efforts be-

provoked them to invent an engine which will be free of these problems and would cruise extremely fast in the skies. Ohain thought of using Newton's third law of motion to realize his dream. According to that, every action has an equal and opposite reaction, as a deflating balloon experiences an opposite force due to the discharge of air. An engine based on a similar principle would be desirable to achieve incredibly high speeds. This engine could be as following:

The air enters from one side of the engine, is compressed and brought to a combustion chamber where combustion takes place. The heat produced by the combustion will explosively push the air outside through a Nozzle and the engine would experience enormous thrust in the opposite direction. Ohain named this machine the Jet engine.

Nobody knew that a machine based on such a simple principle would remain a crucial part of aviation even after 85 years of its invention. A jet engine is heart of today's modern aircraft and enables



gun to develop a new kind of engine. A German physicist Hans von Ohain and an English pilot dreamed of this extraordinary machine for the first time. Steady flying planes simply could not compete the flight of their imaginations. Furthermore, slow speed of ordinary propeller engines, their noise and exhaust annoyed these two inventors too much and

AGRITECH

Citizen-Centric e-governance: Can Pakistan's democracy be improved?



Mirza Abdul Aleem Baig

INFORMATION and Communication Technologies (ICTs) have turned into the miracle medicine for curing any country from the diseases of corruption, mismanagement, poor governance, inflation, monopolies, illiteracy and so forth. ICT tools and techniques to support good governance have considerably changed with the appearance of social media, simulation techniques, opinion mining, open government data, text analytics and visualization. Today, people are more connected than ever before through ICT, linked to family, friends, social groups, and increasingly, government. Similarly, ICT tools are empowering to engage with government and find clarity on issues that touch their lives. In devel-

oped countries, governments are regarding the call to deliver information in a way that create transparency and demonstrates accountability.

In every sector, information and communications technologies (ICTs) are powerful tools for controlling corruption and ill practices. ICT works principally well when they are embedded in extensive institutional reforms. Generally, ICTs for good governance and controlling corruption operate by shining a bright light upon institutional development. ICTs improve transparency particularly at the transactional level, at the same time offer opportunities for easier access to public records, and establishing linkages among geographically separated structures for better accountability.

In every part of the world from industrialized to developing countries, governments are putting information online to provide better services for citizens and good governance. Globally, there are various countries that are

aiming towards refreshing their public administration by making it more proactive, accountable, service-oriented



and transparent. This transformation requires intervention of technology in administration and governance, accordingly ICT can play significantly important role in advancement of public sector

and its governance. Governments around the world are, therefore, making use of ICT as a standard for promoting

Simple, Moral, Accountable, Responsive, and Transparent (SMART) electronic government (e-government). Generally, e-government incorporates three dimensions:

- Democratic dimension

(e-Democracy): Focusing on the political processes and interaction between the constituents and the government.

- Administrative dimension (e-Administration): Including various types of management work, internal and external routines.
- Service dimension (e-Service): Relating to the delivery of all types of services.
- Participation dimension (e-Participation): To engage with citizens and enable deeper contributions and support deliberative debate on policy issues and to support the democratic decision-making process.

UN member states have recognized broad public participation as an essential prerequisite for the attainment of sustainable development. Public participation always has positive repercussion on good governance and adding the 'e' can make good governance better and bad governance worse. Establishing good governance and public participation have

become a key concern for sustainable socio-economic development. It has been acknowledged that development cannot take place without sound and capable governance.

Today, technologies in computing, information system and communication have led to the death of distance and time. Networking technologies work exceptionally fast and can improve anything and everything. Using ICTs to promote, as stated in United Nations Millennium Declaration, "democratic and participatory governance based on the will of the people," may lead to more responsive and effective government. In a nutshell, democracy, good governance and modernity cannot be imported or imposed from outside a country. Let every forum of policy makers, political leaders and ICT professionals' converse and fabricate a comprehensive set of recommendations for the successful execution of anywhere-anytime citizen-centric e-Governance across Pakistan.

ENVIROTECH

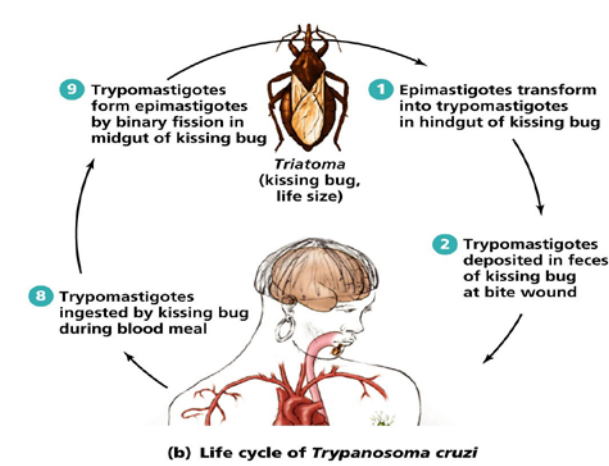
Parasites vs politicians



Suhail Rahujo

THERE ARE two types of strange creatures found on this simple earth whose characteristics are very similar in some or many ways. Parasites are the micro creatures that are always dependent upon other living things for their survival. Politicians are also being dependent upon other people for their survival. Host of parasite always look after it for its survival but in return, parasite always attacks and utilizes all available resources which are belonging to host originally. Politicians are always selected by the people whom they are dependent of but in return, they utilize and own all types of resources which are the sole property of the people. Parasites need a medium to get an entry into the body of host so that it may reside and destroy hosts by only favoring to itself. These mediums are for e.g. misquotes which are living in the polluted water. Politicians also need a medium to get an entry to occupy to rights of people so that they may live a luxurious life by snatching the happiness of the people. These mediums are for e.g. terrorists which are living in the polluted society.

It is the common nature of the host which is always proven to be weak and thus it is easy for the parasite to



get an entry first and then try its level best to decrease the immunity. Despite the weaknesses and fatal health experienced, host is not willing to do preventive measures to stop the parasitic attack and lead his life until death

will knock his door. Same is the case with politician and people. It is a common nature of the people who always declared himself weak and thus it is easy for the politician to attack on the rights of people first and then to minimize the power of freedom of expression treacherously. Despite the huge tension equipped life, people are not willing to change their fate by carefully selecting the politician.

If host is powerful and he knows how to make our immune strong then there is no chance for the parasites to attack and not only this, parasitic behaviour will be changed into symbiotic relationship and thus neither the host nor that parasite is harmed and both will mutually benefit to each other. Same condition is for politician and people too. If people are powerful enough to understand what are their rights and how to own them wisely then there is an obvious chance for the people and politician to live in a friendly environment

and every types of rights are being shifted and handed over to people at their door step.

Like heavy dosage of antibiotic medicine may kill many of our own living cells and may weaken our body which is always not prescribed. Excess of politicians may violate various rights of common people and may induce pessimistic thoughts in the society which is always not suggested.

Literally speaking, Politicians are types of human beings that possess the parasitic characters thus are in the continuous charge to suck the blood of their people whom they benefits. Comprehensive Research on One Parasite and One Politician in One Laboratory can shock the world.

By Usman Butt

INFOTECH

2015 in review telecom sector on growth trajectory

THE YEAR 2015 was bad for the telecom industry of Pakistan as no new foreign direct investment (FDI) came in, all the cellular operators were struggling to increase their average revenue per user (ARPU) to become more competitive and coverage of 3G/4G services was to be expanded, but long-awaited merger was announced in the outgoing year.

Similarly, long-awaited telecom policy was also announced by the Pakistan Telecommunication Authority (PTA) at the end of the year, while Mobilink-Warid merger started the consolidation process in the industry.

It was expected and after the successful merger a new merger is on the scene.

The PTA failed to announce the auction of the remaining available 4G spectrum. None of the existing operators may show interest in it even in the next year.

The finance ministry twice asked the PTA to do auction in order to create budgetary support of around Rs65 billion for the federal government.

The PTA allowed the mergers and acquisitions (along with allocated 100 percent frequency spectrum) even by the two existing operators, provided they have met all the licence obligations, including payment and rollout requirements.

According to the telecom policy, whether a merger or acquisition should be allowed to proceed is a competition matter, which is outside the jurisdiction of spectrum management, and legitimate mergers should

not be impeded by an inability to transfer spectrum licences. Therefore, except where there are overriding technical reasons, or reasons arising out of the national interest, the spectrum rights and obligations of licences will be transferable to the merged or acquiring organisation.

PTA and Pakistan Electronic Media Regulatory Authority are required to intimate the Frequency Allocation Board (FAB) of any merger/acquisition. Interestingly, the telecom policy was announced soon after the Mobilink-Warid merger news.

Market sources said both the companies had to get clearance from regulators, like Securities and Exchange Commission of Pakistan, Competition Commission of Pakistan (CCP) and others.

Zong and Ufone are expected to go for consolidation to remain competitive. After the announcement of the merger, the total subscriber base of the Mobilink-Warid would reach 45 million. Telenor is second with 33 million, Zong 23 million and Ufone 19 million. ARPU of the telecom industry is Rs205.

The merger in the telecom industry was expected for the last five years. Warid had conducted due diligence with a number of local and international players for that.

Industry experts believed that the telecom sector in Pakistan is not too big for five operators; hence mergers in the industry were needed. More consolidations are expected within the next couple of years.

During 2015, good growth in the 3G subscriber base was recorded. Already two million subscribers have started using it, while 4G services subscribers stood at only 400,000. The main hindrance in adoption of 4G service is high cost of 4G-enabled handsets, while Zong, the only company, which acquired the licence of 4G was unable to get the added advantage of the licence.

Customers' complaints regarding the cellular services



increased as all the telecom operators were working on network improvement and integration project after the launch of 3G/4G.

The industry is expanding the network and expecting growth in data subscribers and services.

Impact of Biometric: Total number of mobile subscribers stood at 140 million when the telecom industry started biometric verification of the SIM cards at the end of 2014 on the instructions of the federal government to curb the misuse of mobile phones in terrorism and other crimes.

The PTA data showed that the total mobile subscribers were 120 million by October 2015 after the completion of biometric verification process.

Telecom operators had to invest tremendous effort and resources in this nationwide activity owing to the security situation in the country in the beginning of 2015. However, this activity and investment of telecos seemed to be futile as a tragic incident of the Army Public School took place in which biometric verified SIMs were reported to be used by the attackers.

Fraudulent activities to deceive innocent public in the name of Benazir Income Support Programme stipend, along with many other text message frauds also continued. The authorities are still unable to check this. Interestingly, no such verification was ever done in any part of the world, even in Afghanistan, which has been in a state of war for over a decade and Saudi Arabia where millions of pilgrims visit every year.

Tax issues kept haunting the industry players. The government turned a deaf ear to their demands. The example was an imposition of 19.5 percent general sales tax on data services by the Punjab government. The Punjab government, however, withdrew the tax after six months of its imposition.

None of the operators had deducted this tax from their users in the six-month period (June-November 2015) to promote data usage in Pakistan.

Among many other taxes, sales tax of 19.5 percent on telecommunication and data services is levied in Khyber Pakhtunkhwa and 18.5 percent in Sindh, which is impeding growth of much

required broadband proliferation.

The industry has been so far unable to create local content for the data proliferation, while the data subscribers are mainly using data for emails, global social networking websites and chats.

The rapid data growth is possible only when the local language content will be created by the stakeholders in Pakistan or literacy rate is increased.

India is a successful example of data proliferation through local content development. The telecom industry is not in a mood for further investments due to declining ARPU, increasing taxes and slow growth of data.

A State Bank of Pakistan's report said telecom companies are not reinvesting much and repatriating most of their earnings.

It is important to recall that the telecom sector had the second largest share in FDI in Pakistan after the financial sector.

Its contribution in profit repatriations has generally remained much less than other sectors, as stiff competition and heavy taxation never allowed firms to raise their profit margins. Revenues of the telecommunication companies are constantly declining.

The government policy-makers need to revisit their priorities and create cushion for the once highest FDI attracting industry and one of the largest tax contributing sectors. Otherwise, it will be too late to decide and take measures.

By Jawwad Rizvi



By Faizan Afzal

EDUCATION TECH

Investing in higher education

EDUCATION IS the most powerful weapon and tool that we can employ to eradicate poverty, to nurture puerile minds, to develop ingenious solutions, to banish the scourge of terrorism and the most paramount of all to make us capable enough of standing, with our heads raised, among the comity of nations. Where primary education helps nurture the pre-mature minds; Higher education aides in building economies that control the world.

It is an era of "knowledge-based economy" defined by OECD (Organisation for Economic Co-operation and Development) as "economies, which are directly based on the production, distribution and use of knowledge and information." The term "Human Capital" is the core of "knowledge-based economy". Higher education institutions deliver this "Human Capital"; and thus play a paramount role in the economic development of their countries.

The impact education can have on the economies of countries and its citizens can be seen easily by a mere look on the investment of OECD (a group of 34 countries including USA,

UK, Germany) countries on Higher Education and the benefit they procure of such investment. The OECD countries on average, directly invest more than USD 30,000 in public sector funds to support an individual pursuing higher education. But look at the return; these countries get by investing such a huge amount on higher education. For example, the net return on the public costs to support a man in tertiary education is more than USD 91,000, on average across OECD countries - more than three times the amount of the public investment.

Singapore, a small country with a population of just 5.3 million, has exports of \$518.9 billion particularly in electronics, chemicals and services; 17 times more than Pakistan. This country has the highest trade to GDP ratio in the world. South Korea with a population of 50.2 million i.e. one fourth of Pakistan has exports of \$572.66 billion mainly in semiconductors, wireless telecommunication equipment, motor vehicles; 19 times more than Pakistan's export which are just \$29.8 billion. It is the only developed country included in the group of Next

Eleven countries. These awful figures may impress us but there is a lot of investment these countries have made in educating their youth. The budget of

average of 6.3%. This is how these small countries have reached to such an astonishing level of development.

The alumni of a single

contributed 2.8% of UK GDP, generated significant employment opportunities across the economy, accounting for 2.7% of all UK employment; this was

with spending of 4.6% (2013) and 3.9% (2012) respectively of their GDPs on education while we spend just 2.5% of our GDP on education. The Science De-

educational institutes are the best places to provide such an environment.

Countries don't make progress with roads, Metros and Orange Trains rather it is an outcome of their development. We need to understand that the infrastructure and development we drool over in developed countries is the result of their advancement in technology and research. They invested in their laboratories before investing in roads and trains. We are "180° out of phase" with the developed countries while making investments in Education and infrastructure and kudos to our innocence that we still dream that we can develop.

There is only one way to development and it passes through the bridge of education, and if we will fail in constructing that bridge than we will definitely fall in a river and without learning, one cannot even swim to the other side.

I suggest: 20.5 billion rupees were allocated for Higher Education in the Budget for the Fiscal year 2015-2016 by the govt of Pakistan and this account to only 0.46% of the total budget. Govt. must take steps to increment this no to at least 3% of the

Federal Budget by the year 2018.

In lieu of establishing new campuses without Highly Eligible Faculty and appropriate Labs, Govt. should avail existing universities ameliorate their faculty and research facilities by hiring international Faculty members and engendering more scholarship for local graduates for their PhDs abroad.

Special Budget should be allocated for establishing International standard Libraries and updating the current ones.

There is an inadequate mechanism for checking the Quality of Research papers published by Local researchers. HEC uses Impact Factor to quantify the Quality of Research articles, but there are many imperfections in utilizing Impact Factor because it takes into account the overall citations of the articles of a particular journal in which the article is published not the article itself. At least two other matrices like H-Factor, relative citations, SJR should withal be used. By ameliorating the quality of our research Papers, we can improve the international ranking of our universities and can magnetize an abundance of foreign students.



a single university in Singapore, National University of Singapore, is 160 billion rupees which is several times larger than the total budget of all the universities of Pakistan. In 2010, South Korea spent 7.6% of its GDP on all levels of education - significantly more than the Organisation for Economic Cooperation and Development (OECD)

University MIT in USA have launched 30,200 active companies, employing roughly 4.6 million people, and generating roughly \$1.9 trillion in annual revenues which is even greater than the GDP of world's 10th Largest Economy India. A report published by "Universities UK" show that in 2011-12, the higher education sector in UK

equivalent to 757,268 full-time jobs.

"Education is the investment our generation makes in the future." Mitt Romney

If we look at the expenditure on education as a percentage of GDP of different countries, we find it astonishing that even countries like Afghanistan and India are way ahead of Pakistan

development Budget of Pakistan is just 1 billion while that of India is 200 billion. This is where the priorities lie. Innovation, development and progress are only possible if a country is producing creative minds and creativity is groomed at universities. Creativity demands an environment where ideas may flourish and lead to innovation and

INFOTECH

Emergence of e-sports: Pakistani youth in the digital age

SINCE ITS EXPLOSION across the country's socio-cultural landscape over a decade ago, Computer Network Gaming has left a lasting impact on the lives of Pakistani youth growing up in the 21st century. From its earliest beginnings as a small cult phenomenon taking root in seedy internet cafes, network gaming has more or less become the mainstay of how today's tech savvy youth are expected to socialize and form a healthy hobby around.

Easy to access and with a relatively small learning curve, computer gaming has reached a point where it can be seriously considered to rival youth participation in more traditional outdoor and sporting activities. With Murphy's law providing, smaller, faster and cheaper computers to the masses, the image of pubescent pre-teens and adolescents sitting in their rooms glued to their computer screens has become a mainstay of even middle to low-income households across the country.

Gone are the days of the

age-old fascination with expensive sporting kits. That sports bag with gloves, pads, squash rackets and hockey sticks. Instead it's all about expensive computer keyboards and state of the art headsets all sought to gain a competitive edge on what is now termed as eSports across the world.

So far this phenomenon has been the mainstay of network gaming cafes and off-hour computer labs within schools and colleges across the country. The very idea of network gaming has for more than a decade revolved around a set of computers wired together in a single premises with one of them often dedicated as the host server.

This, however, has changed dramatically with the advent of the Pakistan Gaming Lounge (PGL). Developed and hosted by ICT giant PTCL, PGL offers Pakistan's first online servers dedicated to promoting and organizing eSports within the country. Featuring international tournaments, discussion boards and numerous other help-

ful resources, www.GamingLounge.pk offers a unique platform for the country's gaming community to socialize and interact on.



This move towards an online, cloud-based platform highlights an important step in the development of eSports within the

country. Located within PTCL's state-of-the-art data centers, PGL's servers are geared towards providing a completely lag free gaming

help, competitions across this platform are ensured as being fair and without the presence of the usual profanity and bullying charac-

teristic of this genre. Acting as digital referees the team at PGL can be further seen as bringing a form of organized regularity to some

Global Offensive and Call of Duty that have more or less defined the style and culture of eSports within the country uptil now. By

promoting other multiplayer games such as Minecraft and Team Fortress the service further aims at introducing other popular titles to the Pakistani public, further broadening the scope for eSports within the nation's gaming community. The vast potential of this platform can be easily gauged from the response it received during a live programming competition that took place at the Centaurus Mall in Islamabad quite recently. Hosted on PGL's online platform the live event featured intense rivalries within a highly contested tournament amongst the twin cities top gamers. In itself, it presented an exciting opportunity to help boost the profile of Pakistan's burgeoning gaming community, providing a unique and much-needed platform for them to socialize and compete on.

Participants at this event could be seen wholeheartedly taking advantage of this rare chance amid considerable enthusiasm. Headset in place and mouse in hand, the scene itself presented a

stark image of how far the very concepts of socialization and hobbies amidst our youth have changed in just over a decade into the Digital Age. Perhaps most surprising was the interest showed by spectators for whom a heated competition unfolding in Virtual Reality proved just as exciting as any 'Real' sporting event.

By creating greater awareness for such kinds of eSports in the country, events like these offer an exciting chance for young gamers to participate in a growing and increasingly popular global trend. Further promoting and broadening the scope for eSports within Pakistan allows the country's small yet growing gaming community to better represent itself and compete on a larger regional or even international scale. Perhaps the day is not that far when donning the green uniform of Pakistani sports-teams will hold just as much importance within the arena of eSports as it does now for more conventional sporting competitions.

By Abid Saeed

SCIENCE TECH

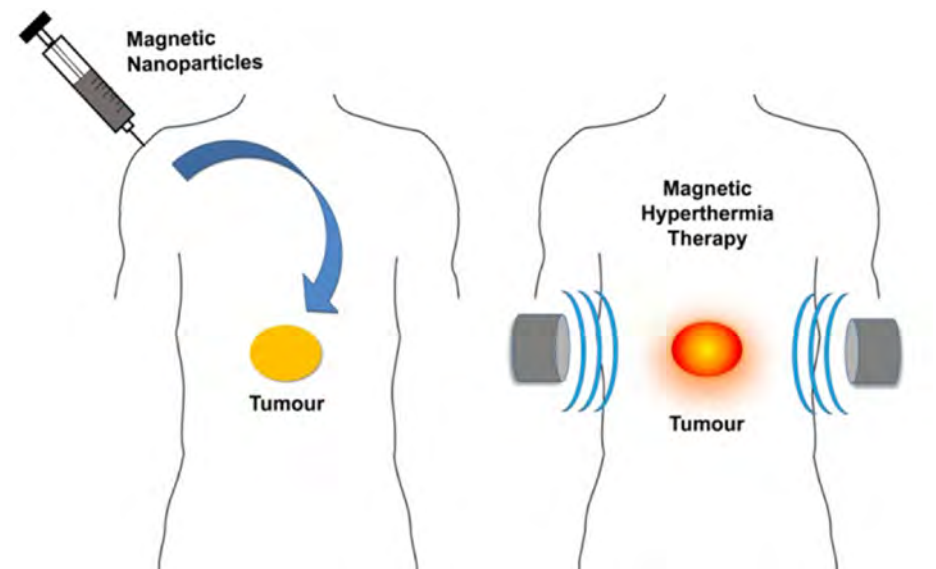
Magnetic Hyperthermia

MAGNETIC HYPER-THERMIA also known as magnetic nanoparticle mediated intracellular hyperthermia, is a thermotherapy which involves targeting of a tumor with the help of magnetic nanoparticles in the presence of external alternating magnetic field that causes production of heat through Néel-relaxation loss of magnetic nanoparticles. Heat generation through Néel-relaxation is due to rapid changes in the direction of magnetic moments, hindered by anisotropy energy that tends to turn the magnetic domain of the magnetic nanoparticle in a given direction according to their crystal lattice structure. As a result, temperature of tumor cells is increased within range of hyperthermia temperature (41 - 46°C).

Tumor cells are more sensitive to heat as compared to normal cells due to poor vascularization, so

the survival rate of tumor cells decrease drastically by increasing temperature and at one stage the tumor cells burst. This thermotherapy specifically destroys the tumor cells without destruction of neighboring healthy cells. There are various magnetic nanoparticles which have hyperthermia potential. In first category magnetite (Fe₃O₄) and maghemite (Fe₂O₃) are included. There is another category which is based on ferrites for example cobalt ferrites (CoFe₂O₄), manganese ferrite (MnFe₂O₄), nickel ferrite (NiFe₂O₄) and lithium ferrite (Li_{0.5}Fe_{2.5}O₄). Another category which is based on metallic nanoparticles such as Ni, Co, Mn, Zn etc. Among all these magnetic nanoparticles, magnetite (Fe₃O₄) nanoparticles are the most promising for magnetic hyperthermia because magnetite has all those characteristics which

are required for biomedical applications such as biocompatibility, non-tox-



icity, superparamagnetism, water-dispersible, ability to leave reticuloendothelial system (RES) and easy preparation.

Magnetite can be stabilized by using different cap-

ping ligands for example dextran, carboxylic acid, polyvinyl alcohol and li-

est method to synthesized iron oxide nanoparticle is co-precipitation. There are three hyperthermia treatments 1) Local hyperthermia treatment is used to treat the small portion of body such as tumor and it requires very high temperature to

treat the tumor. 2) Regional hyperthermia is used to treat the large area of body such as an organ, body cavity etc. Various methods are used to perform regional hyperthermia such as regional perfusion and in this technique not too much high temperature is required. 3) Whole body hyperthermia is used to treat metastatic cancer i.e. cancer which has spread within whole body. General mechanism of magnetic hyperthermia consists of two steps 1) preparation of magnetic nanoparticles 2) injection of magnetic fluid carrying magnetic nanoparticles into tumor site. There are various ways through which magnetic fluid can be injected to tumor. Arterial injection is that way in which magnetic fluid is injected through artery supply of tumor. Direct injection is that way in which magnetic fluid is directly injected inside the tumor.

The magnetic nanoparticles can also be strategically surface functionalize to target the tumor cells. Active targeting is very complicated way to inject magnetic fluid inside the tumor. This way is related to antibody targeting so for antibody targeting magnetic nanoparticles are coated with antibody of the desired tumor. The efficiency of this thermotherapy is determined by the ability of magnetic nanoparticles to be collected inside the desired area of body. Once the magnetic nanoparticles are entered into the cancer cells through endocytosis they are heated with the help of an external localized and alternating magnetic field. An alternating external magnetic field causes the magnetic nanoparticles within the tumor tissue to vibrate and this vibrational energy is ultimately converted into heat causing the increase of lo-

cal temperature of cancerous tissue leading to its destruction. Magnetic hyperthermia is most promising technique as compared to other therapies because of these advantages; 1) a single administration in tumor is sufficient, 2) higher efficiency for low heating temperature due to intracellular heating, 3) possibility to target the tumor cells selectively and 4) magnetic hyperthermia can also be used in combination with radiotherapy and chemotherapy. Magnetic hyperthermia is most favorable technique to enhance quality of cancer treatment. Methods for injection of nanoparticles and active targeting of the tumor cells, development of different more efficient heat-producing nanoparticles, and monitoring of heat distribution are the essential parts of the upcoming research in this direction.

By Amber Zahra and Dr. Muhammad Irfan Majeed

